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Using the Argonne Diet in Jet Lag Prevention: Deployment of Troops across Nine Time Zones

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Jet lag, a varying set of symptoms affecting performance and judgment in people who fly long distances, may have serious consequences for military personnel and operations. Diet is postulated as one low-cost, safe, and easily altered factor that may modify jet lag. Incidence and patterns of jet lag were evaluated, as well as an intervention with the Argonne diet, which alternates moderate feasting and fasting 4 days before departure, in 186 National Guard personnel deployed across nine time zones. As volunteers, 95 used the diet in preparation for deployment and 39 used it in preparation for return. Jet lag was significantly more frequent on either deployment or return or both for nondieters. Sedentary civilian jobs and a previous history of jet lag were associated with jet lag in this study.

Introduction

Jet lag,[1,2] a variable constellation of negative symptoms affecting people after long-distance travel, can cause discomfort and impair work performance.[3,4] Crossing three time zones can lead to significant jet lag,[5] and readjustment usually takes 1 day for each time zone crossed.[6] Eastbound travel is more disruptive than westbound travel because of the absolute loss of real time, which offsets circadian rhythm more than a gain in time with westbound flight. Typical symptoms include lethargy, fatigue, somnolence, insomnia, inattentiveness, decreased motivation, disorientation, attitude problems, nausea, anorexia, and irritability.

Jet lag is believed to arise from failure of the biological clock to adjust quickly to phase shifts in the external environment.[2] This clock, or "circadian oscillator," is located in the suprachiasmatic nucleus of the anterior hypothalamus. It regulates energy metabolism and hormonal and neuronal control of several body functions required on demand for peak performance and normal immune status.[7,8] Approaches to the control of jet lag range from chemical substances to phototherapy.[9,10]

Flight crews have found that retaining home-based sleep patterns during layovers reduces jet lag symptoms effectively.[11] Troops brought to a training exercise or a combat situation have to assume a new and often quite different sleep/wake cycle without time to accommodate. The Argonne diet has been proposed as one answer to this dilemma.[10] Our purpose in this article is to show the frequency of jet lag among troops deployed across multiple time zones, to show the effect of the Argonne diet in preventing jet lag, and to encourage further study of dietary interventions.

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The Argonne Diet and Theoretical Basis

The Argonne diet was proposed by Charles Ehret of the Argonne National Laboratory (a research facility of the U.S. Department of Energy operated by the University of Chicago in Argonne, Illinois) based on preliminary results obtained from metabolic studies to prevent circadian disruption in rodents and then adapted for jet lag prevention in humans.[10] The Argonne diet (Fig. 1) alternates days of "feasting" on high-protein breakfasts and lunches and high-carbohydrate dinners with days of "fasting," defined as eating small, low-calorie meals (800 calories per day). The feeding hypothesis proposes that high-protein meals raise plasma amino acid precursors to brain catecholamines, whereas high-carbohydrate meals prepare the body for sleep. Abrupt changes in the length of day disrupt the internal clock's control of normal variations in metabolism and physiology, which we depend on for feelings of well-being, energy level, and immunity.[8] The train of alternate-day feeding reduces the impact of a sudden time shift on the internal clock.

Argonne dieters start by feasting on the 4th day before their deployment flight. This is followed by alternate days of fasting and feasting. During the first 3 days before departure, caffeine-containing drinks are allowed between 3:00 and 5:00 p.m. On the departure day, feasting occurs and caffeine is permitted in the morning for a westbound flight or between 6:00 and 11:00 p.m. for an eastbound flight. No alcohol may be consumed on the plane during transit.

Methods

Participants

One hundred eighty-six soldiers (134 from the 125th FA Battalion of the Minnesota Army National Guard and 52 from the 57th FA Brigade of the Wisconsin Army National Guard) participated. Mean age was 33 years (range, 19–58 years); 96% were male. Both states are in the central standard time zone. Nine time zones were traversed before arriving in theater for immediate participation in a joint forces exercise with South Korean troops. Security restrictions prohibit the disclosure of specific details.

Protocol

During predeployment briefings in the United States, soldiers were told about the Argonne diet and given written instructions. They could choose to use the diet for either or both directions or not at all. All soldiers were given questionnaires about diet, activities, and symptoms and history of jet lag, which were collected by commanders and sent to higher headquarters for tabulation.

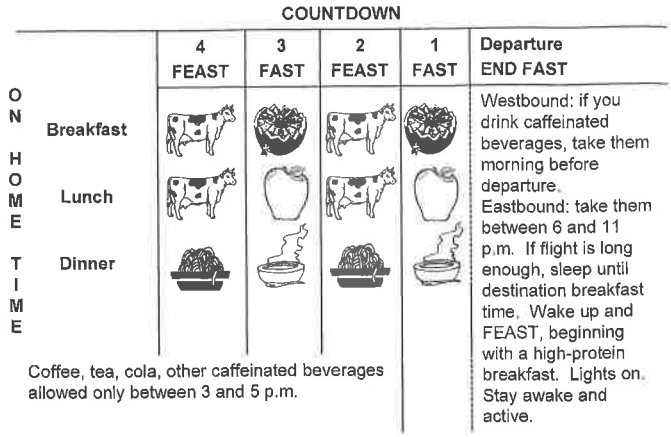

Fig. 1. The Argonne diet alternates days of feasting and fasting, with suppers being relatively high in carbohydrate. On feast days, the cattle symbolizes protein, which includes all meats, fish, eggs, and milk, and the heaping bowl of pasta can have a tomato-based sauce with some selected protein (meat, fish, or cheese) for flavor. Fast days include a variety of fruits for breakfast and lunch, with a bowl of vegetable soup for supper (kcal, 100–250 per bowl). There is no caloric limit for feast days, but fast days should be limited to 800 kcal.

Data Analysis

Univariant analyses used Pearson's χ^2 test. Odds ratios showed the strength of associations. The relationship between the two outcomes (jet lag after deployment and jet lag after return home) and any associations of these outcomes with multiple independent variables required multiple logistic regression. All analyses were performed with the Stata 6.0 statistical software package (Stata Corporation, College Station, Texas).

Results

Questionnaires were collected from all 186 deployed personnel. Ninety-five soldiers used the diet for deployment, and 39 soldiers used it on return. Of the 186 personnel deployed, 49 (26%) experienced jet lag after arriving in Korea and 132 (71%) experienced jet lag after returning home (Table I). The duration of jet lag deploying (1–6 days; median, 3 days) was less than that upon returning (1–14 days; median, 4 days). Morbidity was greater after the return home than upon deployment (Table II).

TABLE I

EXPERIENCE OF JET LAG (N = 186)

	Number	Percent
Ever experienced jet lag before	91	49
Jet lag going to Korea	49	26
Number using diet to Korea	95	51
Dieters who developed jet lag	9 of 95	9
Number not using diet to Korea	91	49
Nondieters who developed jet lag	40 of 91	44
Number using diet upon return	39	21
Dieters who developed jet lag	10 of 39	26
Number not using diet upon return	147	79
Nondieters who developed jet lag	122 of 147	83

Median length of jet lag was 3 days in Korea (1–6 days; n = 51) and 4 days after returning home (1–14 days; n = 127).

TABLE II

JET LAG SYMPTOMS (N = 186)

Symptom	Percent
Contracted an illness during Korea	20
Contracted an illness within 1 week of return	31
Experienced difficulty sleeping after return	67

Experienced within 1 Week	Korea	Return Home
Unable to concentrate	8%	22%
Insomnia	8%	30%
No appetite	5%	10%
Irritable	10%	21%
Fatigue	10%	29%
Bad dreams	5%	11%
Moody	8%	16%
Headaches	4%	13%
Confusion	8%	17%
Bad attitude	8%	13%
Nausea	1%	3%
Jumpiness	5%	16%
Frequent urination	4%	5%
Menstrual irregularity (out of seven females)	29%	29%

Jet Lag after Deployment

Soldiers who did not use the diet (91) were 7.5 times more likely (Pearson's $p < 0.0005$) to have reported jet lag than those who used the diet (95). The Argonne diet was protective against jet lag upon arrival (odds ratio = 0.09; N = 186; $p < 0.0005$), but a past history of jet lag increased the odds of jet lag upon arrival (odds ratio = 2.80; N = 186; p = 0.010). A similar result was found when the outcome was either jet lag or any symptom or combination of symptoms of jet lag (odds ratio = 2.8; N = 186; p = 0.001).

Jet Lag after Returning Home

Failure to use the Argonne diet, a sedentary job at home, and previously reported jet lag were each significantly and independently associated with the report of jet lag after returning home. (Twenty-five questionnaires had no information on the subject's job at home and were eliminated from analysis with respect to sedentary lifestyle. This leaves a population base of 161, of which 34 used the diet.) The odds of reporting jet lag for the 127 who did not use the diet was 16.2 times greater than for the 34 who did use the diet ($p < 0.0005$; N = 161; logistic regression). Those who reported jet lag on deployment were 3.2 times (p = 0.04) more likely to report jet lag on returning home. The Argonne diet was effective in preventing jet lag after returning home (odds ratio = 0.03; N = 161; $p < 0.0005$), but a past history of jet lag (odds ratio = 4.25; N = 161; p = 0.012) and a sedentary lifestyle (odds ratio = 2.86; N = 161; p = 0.039) increased the odds of jet lag after return. Similar results were obtained when the outcome was either jet lag or any of the symptoms of jet lag. (Those not using the Argonne diet had an odds ratio of 10.3 [$p < 0.0005$]; those having a sedentary job had an odds ratio of 5.7 [p = 0.03].)

Discussion

This is the first study showing the effectiveness of the Argonne diet in preventing jet lag of military personnel deployed across time zones. Physical activity is a factor in preventing jet lag, which was reported more frequently by those with sedentary occupations. A past history of jet lag as a predictor of repeated jet lag suggests that certain individuals could have susceptible constitutions. Whether this is independent of overall physical activity needs to be determined.

The problems inherent in jet lag are not inconsequential, particularly for military personnel. Ironically, improvements in transport exacerbate the problem: speedy and early arrival of soldiers into operational theaters via high-speed aircraft can be offset by the deleterious effects of jet lag on troop performance. Although there are no published studies of jet lag in the military, its impact can be inferred from other studies. Studies of competitive athletes have shown the negative impact on physical performance in baseball[12] and on Olympic squads[13] traveling across multiple time zones. These athletes presumably had "normal," relatively comfortable environments but still suffered performance degradation.

Several methods of preventing jet lag have been proposed.[14,15] However, the Argonne diet has the advantages of being simple, inexpensive, convenient, and readily available and causing few side effects (only six individuals reported some degree of impaired work performance on fast days, but none significant enough to discontinue the diet). This study suggests that it is effective as well. Unlike sleeping pills or sedative medication sometimes used to treat disrupted sleep patterns, this diet has no "hangover" effect to impair judgment or performance. Indeed, attempts to limit jet lag by recovering "lost" sleep are ineffective, because the phenomenon is not caused by a lack of sleep but by a disruption of one's biological clock. Establishing regular sleep-wake cycles with regular meals and exercise as soon as possible will help "reset" a reliable biological clock.

The last 5 days of overseas training were on a U.S. Army post, devoted to maintenance requirements and preparations for the return home. Appropriate diet options were available in the Army mess hall, where soldiers could select calorie-controlled meals. Control of departure timelines and of eating behavior is essential for individuals using the Argonne diet.

Jet lag in time zone shifts going east are generally thought to be more severe,[16] yet fewer soldiers selected the diet for the return home. We now know that the recurrence of jet lag upon return is predictable, because those reporting it upon deployment had a 2.5 times greater chance of having it upon return. In addition, upper respiratory illness was more frequently encountered upon return (31%) than after deployment (20%), and the duration of jet lag was greater at home than in Korea. In this study, the "mission was over," and with it, the sense of urgency related to performance. However, reservists have an additional concern with their civilian employers if jet lag symptoms affect work performance.

Study Limitations

Larger and better controlled series need to be used to verify the usefulness of the Argonne diet. The convenience sample used here was geographically and demographically narrow. Self-report is subject to inaccuracy, and the time lag in recording information increases that limitation. Diet use was entirely voluntarily. Although the nonusers form a pseudocontrol group, the disparity in group size and the small size of the study group limits the interpretation of the results, as does self-selection: the volunteer group may have different characteristics than those who declined. Placebo effects also could play a role in outcome, because the diet plan was explained to all soldiers to help them make informed choices. Our study was dependent on the discipline of volunteers to use the diet guidelines appropriately. A more controlled study with active duty personnel would be able to certify standardized meals, physical activity levels, and the effects of shift assignment before and after deployment.

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